

AMENDED CLAIMS

[received by the International Bureau on 28 March 2005 (28.03.05);
original claims 1-19 replaced by new claims 1-18 (4 pages)]

1.- Cooling for an electric motor or generator consisting of a housing, what is called a "slotless" tubular stator lamination (4), a rotor (2) with permanent magnets and electric windings (25-26) which are provided between the stator lamination (4) and the rotor (2), characterised in that the cooling comprises a cooler (6) upon which said windings (25-26) are provided and which is formed of a cooling element (7) which is provided between the stator lamination (4) and the rotor (2) and which cooling element (7) is provided with teeth (12) directed radially towards the rotor (2) which extend in the axial direction of the stator (1) and in between which axially directed grooves (13) are defined, such that the cooling element (7) has an external form of a conventional stator lamination with teeth for providing said windings (25-26).

2.- Improved cooling according to claim 1, characterised in that the above-mentioned teeth (12) and grooves (13) are evenly distributed over the inner perimeter of the cooler (6).

3.- improved cooling according to claim 1, characterised in that the above-mentioned windings (25-26) are provided around the above-mentioned teeth (12), whereby these windings (25-26) have axial parts (25) which extend in the above-mentioned grooves (13) and bent parts (26) which are bundled together into what is called a winding head (27) on both far ends of the stator (1).

4.- Improved cooling according to claim 1, characterised in that the cooler (6) is formed of a cooling element (7) with one or several passages (15) for a cooling fluid.

5.- Improved cooling according to claim 4, characterised in that the above-mentioned passages (15) are axially directed and are connected to an outlet collector (8) on one far end of the stator (1) and to an inlet collector (9) on the other far end of the stator (1) respectively.

6.- Improved cooling according to claim 4, characterised in that the above-mentioned cooling element (7) is formed of a double-walled tube with an outer tube (10) and an inner tube (11).

7.- Improved cooling according to claim 6, characterised in that the outer tube (10) is a cylindrical tube whose outer diameter corresponds to the inner diameter of the stator lamination (4), whereas the inner tube (11) is a corrugated tube with axially directed teeth (12) and grooves (13), whereby the outer and the inner tubes (10-11) are connected to each other by means of partitions (14) which, together with the outer and the inner tubes (10-11), define the above-mentioned passages (15) for the cooling fluid.

8.- Improved cooling according to claim 4, characterised in that the cooling element (7) is formed of axially directed pipes (29) which form the above-mentioned passages (15) and which are provided at mutually equal distances from each other between the stator lamination (4) and the rotor (2) and are cased at least with their far ends in two ring-shaped flanges (30) which are fixed in the stator lamination (4).

9.- Improved cooling stator according to claim 8, characterised in that at least a part of the above-mentioned pipes (29) are situated partially between the axial parts (25) of the above-mentioned windings (25-26).

10.- Improved cooling according to claim 8, characterised in that the above-mentioned ring-shaped flanges (30) are provided with teeth (33) which are radially directed towards the rotor, in between which the above-mentioned windings (25) are provided.

11.- Improved cooling according to claim 10, characterised in that the space between the pipes (29) and the axial parts (25) of the windings (25-26) is at least partially filled with a thermally conductive and electrically insulating filling material (35).

12.- Improved cooling according to claim 4, characterised in that the above-mentioned outlet and inlet collectors (8-9) are each formed of a ring-shaped element which confines a ring-shaped chamber (37), whereby this ring-shaped element is connected to a side wall (19) against a far end of the cooling element (7) and whereby this side wall (19) has been worked open at the above-mentioned passages (15) of the cooling element (7).

13.- Improved cooling according to claim 12, characterised in that each above-mentioned ring-shaped element is connected to the above-mentioned housing (3) with an outer wall (16) and in that at least one opening (20-21) is provided in this outer wall (16), which opening is situated

opposite to an outlet opening (21), inlet opening (23) respectively, in the housing (3).

14.- Improved cooling according to claim 13, characterised in that in the above-mentioned ring-shaped element in the wall (17) directed towards the rotor (2) is provided a recess (36) in which the winding head (27) is cased on the far end concerned of the stator (1).

15.- Improved cooling according to claim 4, characterised in that the above-mentioned outlet and inlet collectors (8-9) are formed of a ring-shaped chamber (37) which is confined by the housing (3); of the cooling element (7); of an inner tube (38) which is provided concentrically in the cooling element (7); and of a ring-shaped lid (39) which is connected to the housing (3) and to the above-mentioned inner tube (38).

16.- Improved cooling according to claim 15, characterised in that in the housing (3), at the height of the outlet and inlet collectors (8-9), is provided at least one outlet (21) or inlet opening (23) respectively.

17.- Improved cooling according to claim 1, characterised in that the cooler (6) is made of a thermally conductive and electrically insulating material.

~~18.- Improved cooling according to claim 1, characterised~~
in that the cooler (6) forms a separation between the cooling fluid and the electric windings (25-26).

~~Improved~~ Cooling for an electric motor or generator.

The present invention concerns ~~an improved~~ cooling ^{for} ~~of~~ an electric motor or generator, more particularly what is called a "slotless" permanent magnet motor or generator.

5 It is known that such a "slotless" permanent magnet motor or generator is mainly composed of a housing and, in this housing, what is called a "slotless" tubular stator lamination with a smooth inner wall and electric windings wound in or around said tubular stator
10 lamination on the one hand, and a rotor which is provided with permanent magnets on the other hand.

Such motors and generators which are equipped with a cooling formed of a cooling jacket provided on the outside of the stator through which cooling fluid flows
15 is already known.

~~----- A disadvantage of such known stators is that the cooling -----~~
at the rotor is often insufficient.

It is also known that "slotless" permanent magnet motors or generators are often provided with an air cooling,
20 whereby air is blown over the winding heads of the stator by means of an external fan or by means of a screw or blades in one or other form, fixed on the

4

*<< upon which said windings are provided
and which is formed of a cooling element >>*

magnet motor or generator cannot be realised in a simple manner, and the cost price of such a motor or generator is usually very high.

Another major disadvantage of the present known
5 permanent magnet motors or generators, for example as in
the case of the above-mentioned WO 01/35513 and US
5,304,883, is that providing the windings is very
laborious, time-consuming and expensive, since the
"slotless" stator lamination in this case has a smooth
10 inner wall without any teeth, around which the windings
can be wound, as in the case of motors or generators
with a conventional stator lamination.

The present invention aims to remedy the above-mentioned
and other disadvantages.

15 To this end, the invention concerns ~~an improved cooling for~~
~~of~~ an electric motor or generator consisting of a
housing, what is called a "slotless" tubular stator
lamination, a rotor with permanent magnets and
electric windings provided between the stator
20 lamination and the rotor, *<<>>* characterised in that the
cooling comprises a cooler which is provided between the
stator lamination and the rotor and ~~in that the windings
are provided on this cooler~~ *which cooling element* (X)

→ 4A

~~An advantage of such a motor or generator according to~~
25 ~~the invention is that the cooling is applied in the
immediate environment of the rotor and of the windings of
the stator, as a result of which a very efficient~~

4A

~~Cooling of the rotor with its magnets and the tube which holds the magnets on the rotor, as well as of the stator windings is obtained.~~

Another advantage is that such a motor or generator with an internal cooling is more compact than a known motor or generator with an external cooling jacket and a comparable capacity.

Another advantage is that, since the cooling is provided internally in the stator, such a stator can be used for closed motors or generators which are applied for example in dusty and damp environments or in environments with flammable or corrosive gasses.

The above-mentioned cooler [⊗] is preferably provided with ~~radial~~ ^{radially} teeth directed towards the rotor which extend in the axial direction of the stator and in between which axially directed grooves are defined, such that the cooling element ~~cooler~~ has an external shape of a conventional stator lamination *with teeth for providing said windings.*

→ 4B

An advantage of such a cooler is that the above mentioned windings can be provided in a very simple manner in the above-mentioned grooves around the above-mentioned teeth, more particularly in the same manner as in the case of the conventional asynchronous or synchronous motors and generators which are provided with a stator lamination with teeth.

- 4B -

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lamination, a rotor with permanent magnets and
electric windings provided between the stator
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→ 5

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~~The above mentioned cooler is preferably provided with radial teeth directed towards the rotor which extend in the axial direction of the stator and in between which axially directed grooves are defined, such that the cooler has an external shape of a conventional stator lamination.~~

Still another,

~~an~~ advantage of such a cooler is that the above-mentioned windings can be provided in a very simple manner in the above-mentioned grooves around the above-mentioned teeth, more particularly in the same manner as in the case of the conventional asynchronous or synchronous motors and generators which are provided with a stator lamination with teeth.

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